COMPLETE LISTING OF CLAIMS

Please cancel claims 1-3 and enter the following new claims. This listing of claims will replace all prior versions, and listings, of claims in the application:

In the Claims:

I claim:

1-3. (cancelled).

4. (new) A method of limiting the travel of an assembly tool used within a workstation, the method comprising the steps:

(a) setting at least one spatial boundary of a workstation such that the workstation is adapted to sequentially receive movable work-pieces, the workstation being further adapted to receive only a single work-piece at any one time;

(b) providing an assembly tool comprising:

a base;

an end use device adapted to perform an assembly operation upon such work-pieces;

a flexible connector having a first end connected to the base and a second end connected to the end use device, the flexible connector extendable to a length that allows travel of the end use device beyond a selected boundary of the workstation;

(c) providing a travel limiting assembly adapted to fixedly attach to the assembly tool; and

(d) attaching the travel limiting assembly to at least one portion of the assembly tool such that travel of the end use device is restricted to within a tool travel envelope defined, at least in part, by said selected boundary of the workstation.

5. (new) The method of claim 4, wherein the flexible connector comprises a flexible conduit.

6. (new) The method of claim 5, wherein the flexible conduit comprises at least one power conduit selected from the group consisting of an electrical power cable, an electrical control cable, a pneumatic power hose, a pneumatic control hose, a hydraulic power hose, a hydraulic control hose and combinations thereof.

7. (new) The method of claim 4, wherein the flexible connector comprises a connector selected from the group consisting a rope, a chain, a wire, a cable, an elastic cord and combinations thereof.

8. (new) The method of claim 4, wherein the flexible connector comprises an articulated arm.

9. (new) The method of claim 4, wherein the end use device comprises a tool driven by a motor.

10. (new) The method of claim 4, wherein step (d) comprises the step of:

fixedly attaching the travel limiting assembly to the end use device.

11. (new) The method of claim 10, wherein the travel limiting assembly comprises a flexible tether.

12. (new) The method of claim 4, wherein step (d) comprises the step of;

fixedly attaching the travel limiting assembly to at least one portion of the flexible connector.

13. (new) The method of claim 12, wherein the flexible connector comprises a flexible conduit, and

wherein the travel limiting assembly further comprises:

a clamping assembly fixedly receiving a first portion of the flexible conduit; and

a flexible tether having a first end attached to the clamping assembly and a second end attached to a pivot so as to restrict the travel of the end use device to within a tool travel envelope defined, at least in part, by said selected boundary of the workstation.

14. (new) The method of claim 13, wherein the pivot is attached to the base.

15. (new) The method of claim 13, wherein the pivot is positioned a pivot offset distance from the base.

16. (new) The method of claim 4, wherein step (d) further comprises the step of;

fixedly attaching the travel limiting assembly to at least two portions of the flexible connector.

17. (new) The method of claim 16, wherein the flexible connector comprises a flexible conduit, and

wherein the travel limiting assembly further comprises:

a clamping assembly fixedly receiving a first portion and a second portion of the flexible conduit so as to restrict the travel of the end use device to within said selected boundary of the workstation.

18. (new) The method of claim 4, wherein step (d) comprises the step of;

fixedly attaching the travel limiting assembly to at least one portion of the flexible connector, and

wherein the travel limiting assembly comprises a clamping assembly, the clamping assembly comprising:

a first block having a first channel receiving a first portion of the flexible connector; and

a second block disposed adjacent to the first block so as to fixedly retain the first portion of the flexible connector within the first channel.

19. (new) The method of claim 18, wherein the clamping assembly further comprises:

at least one fastener assembly disposed so as to hold the second block adjacent to the first block;

at least one tamper resistant shield, each tamper resistant shield disposed adjacent to at least one fastener assembly so as to inhibit operation of the adjacent fastener assembly.

20. (new) The method of claim 19, wherein the clamping assembly further comprises:

at least one retaining device, each tamper resistant shield having a retaining device disposed so as to inhibit movement of the tamper resistant shield .

21. (new) The method of claim 21, wherein each retaining device comprises a quality control device selected from the group consisting of a quality control tag, a quality control band, a quality control label, and a quality control tape.

22. (new) A method for performing assembly operations upon a plurality work-pieces moved by an automatic conveyance system, the method comprising the steps:

(a) moving a plurality of work-pieces along a conveyor footprint by means of an automatic conveyance system, each work-piece having a first point-of-use;

(b) providing a primary workstation disposed upon the conveyor footprint and at least one secondary workstation disposed upon the conveyor footprint adjacent to the primary workstation, the primary workstation being further adapted to receive only a single work-piece at any one time,

the primary workstation having a first assembly tool disposed so as to perform a first assembly operation upon the first point-of-use of each such work-piece as may be sequentially received within the primary workstation, the first assembly tool comprising:

a base;

an end use device adapted to perform a first assembly operation upon the first point-of-use of such work-pieces; and

a flexible connector having a first end connected to the base and a second end connected to the end use device, the flexible connector being extendable such that, for at least one secondary workstation, the travel of the end use device would allow the end use device to be positioned so as to perform a first assembly operation upon the first point-of-use of at least one such work-piece as may be received within such secondary workstation;

(c) providing a travel limiting assembly adapted to fixedly attach to the first assembly tool; and

(d) attaching the travel limiting assembly to at least one portion of the first assembly tool such that travel of the end use device is restricted so as to prevent the end use device from being positioned upon the first point-of-use of any such work-piece as is received within any secondary workstation.

23. (new) The method of claim 22, wherein at least one secondary workstation comprises an upstream workstation adjacent to the primary workstation, the automatic conveyance system adapted to sequentially move a plurality of uniquely identified work-pieces from such upstream workstation into the primary workstation, each uniquely identified work-piece having associated work-piece identification data,

wherein, the automatic conveyance system further comprises:

at least one sensor adapted to determine the presence and the work-piece identification data of a uniquely identified work-piece when such work-piece is at a selected fixed point boundary or a selected electronic boundary of the primary workstation; and

a database having register files associated with the primary workstation, the database adapted to receive and store work-piece identification data in such register files,

wherein, the automatic conveyance system is adapted to monitor the activation of the first assembly tool and provide to the database such assembly tool activation data as corresponds with selected activations of the first assembly tool,

wherein, the database is further adapted to update and store assembly tool activation data in the designated register file,

wherein, the method further comprises the steps performed by the automatic conveyance system, including:

moving a uniquely identified work-piece from an upstream workstation into the primary workstation;

determining the presence of the uniquely identified work-piece at a first fixed point boundary of the primary workstation;

determining the work-piece identification data of such uniquely identified work-piece; and

recording the work-piece identification data in a database register file associated the primary workstation,

determining the occurrence of selected activations of the first assembly tool, such selected activations occurring after the automatic conveyance system determines the presence of the uniquely identified work-piece at a first fixed point boundary of the primary workstation,

providing the associated assembly tool activation data to the database;

recording the first assembly tool activation data in the database register file associated the primary workstation,

wherein, the flexible connector of the first assembly tool is extendable such that the travel of the end use device would allow the end use device to be positioned so as to perform a first assembly operation upon the first point-of-use of the uniquely identified work-piece while being moved from the upstream workstation into the primary workstation before the automatic conveyance system determines the presence of the uniquely identified work-piece at the first fixed point boundary of the primary workstation, and

wherein, step (d) further comprises:

attaching the travel limiting assembly to at least one portion of the first assembly tool such that travel of the end use device is restricted to within a fixed point tool travel envelope, the fixed point tool travel envelope having a boundary comprising the first fixed point boundary of the primary workstation .

24. (new) The method of claim 23, wherein, the method further comprises the steps performed by the automatic conveyance system, including:

moving the uniquely identified work-piece out of the primary workstation; and

determining the presence of the uniquely identified work-piece at a second fixed point boundary of the primary workstation,

preventing the recording in the database register file of the first assembly tool activation data associated with activations of the first

assembly tool occurring after the automatic conveyance system determines the presence of the uniquely identified work-piece at the second fixed point boundary of the primary workstation,

wherein, selected activations of the first assembly tool comprise activations occurring before the automatic conveyance system determines the presence of the uniquely identified work-piece at the second fixed point boundary of the primary workstation,

wherein, the flexible connector of the first assembly tool is extendable such that the travel of the end use device would allow the end use device to be positioned so as to perform a first assembly operation upon the first point-of-use of the uniquely identified work-piece as it is being moved out of the primary workstation after the automatic conveyance system determines the presence of the uniquely identified work-piece at the fixed point boundary of the primary workstation, and

wherein, step (d) further comprises:

attaching the travel limiting assembly to at least one portion of the first assembly tool such that travel of the end use device is restricted to within a fixed point tool travel envelope, the fixed point tool travel envelope having a boundary comprising the second fixed point boundary of the primary workstation .

25. (new) The method of claim 23, wherein, the automatic conveyance system is adapted to perform the following steps further comprising the method:

determining the presence of a uniquely identified work-piece at a first electronic boundary of the primary workstation,

wherein, the selected activations of the first assembly tool comprise activations of the first assembly tool occurring while the uniquely identified work-piece is determined to be within an electronically monitored work envelope, the electronic work envelope defined, at least in part, by the first electronic boundary of the primary workstation

and

wherein, step (d) further comprises:

attaching the travel limiting assembly to at least one portion of the first assembly tool such that travel of the end use device is restricted to within the electronically monitored work envelope.

26. (new) The method of claim 24, wherein, the automatic conveyance system is adapted to perform the following steps further comprising the method:

determining the presence of a uniquely identified work-piece at a second electronic boundary of the primary workstation;

wherein, the electronic work envelope defined, at least in part, by the second electronic boundary of the primary workstation.

27. (new) A method for performing assembly operations upon a plurality work-pieces moved by an automatic conveyance system, the method comprising the steps:

(a) providing an automatic conveyance system comprising:

a work-station defined along a conveyor footprint, the work-station comprising:

a work-station envelope;

a first fixed stopping point;

a second fixed stopping point;

a work station forward electronic boundary; and

a work station rear electronic boundary; and

an integrated conveyor monitoring and control system adapted to control the movement of a plurality of work-pieces into the work-station from an upstream direction and out of the work-station along a downstream direction, each work-piece having at least one point-of-use,

wherein the travel of such points-of-use along the conveyor footprint define a horizontal transport line,

wherein the work station is adapted to receive an in-station work-piece, the in-station work-piece having an in-station point-of-use for designated assembly operations within work station envelope, and

wherein the automatic conveyance system is adapted to que an out-of-station work-piece having an out-of-station points-of-use upstream and outside of work station envelope;

(b) providing a assembly tool comprising:

a base;

a pivot;

an end use device adapted to perform a designated assembly operation upon such points-of-use;

a flexible power transfer conduit having a first end connected to the base and a second end connected to the end use device, the flexible power transfer conduit extendable to a length that allows travel of the end use device within a assembly tool travel envelope which overlaps the position of the in-station points-of-use on such in-station work-pieces and also overlaps at least one out-of-station points-of-use on such out-of-station work-piece;

(c) providing a clamping assembly having a first end adapted to attach to the pivot and a second end adapted to connected to the flexible power transfer conduit so as to restrict the travel of the travel of the end use device;

(d) measuring a fixed stopping point differential distance, the fixed stopping point differential distance being the scalar distance between the first fixed stopping point and the second fixed stopping point;

(e) measuring an in-station point-of-use offset distance, the in-station point-of-use offset distance being the distance measured from the in-station point-

of-use to the second fixed stopping point, the in-station point-of-use offset distance being a positive value when measured along the downstream direction and negative when measured along the upstream direction;

(f) measuring an out-of-station point-of-use offset distance, the out-of-station point-of-use offset distance being the distance measured from the work station forward electronic boundary to the out-of-station point-of-use, the out-of-station point-of-use offset distance being a positive value when measured along the downstream direction and negative when measured along the upstream direction;

(g) calculating a lateral offset distance, the lateral offset distance being the scalar distance measured between the pivot point and a horizontal transport line;

(h) calculating a pivot point positive horizontal offset using the formula: P = (X/2) + Y + Z, wherein:

P equals the pivot point horizontal offset distance;

X equals the fixed stopping point differential distance;

Y equals the in-station point-of-use offset distance; and

Z equals the out-of-station point-of-use offset distance;

(i) calculating a pivot point negative horizontal offset using the formula: P = X - Y, wherein:

P equals the pivot point horizontal offset distance;

X equals the fixed stopping point differential distance;

Y equals the in-station point-of-use offset distance; and

(j) positioning the pivot to a point being a pivot point horizontal offset distance from the second fixed stopping point and being the lateral offset distance from the horizontal transport line,

wherein, if the value of P is greater than the value of X, then the pivot point horizontal offset distance equals the pivot point negative horizontal offset distance, else the pivot point horizontal offset distance equals the pivot point positive horizontal offset distance

(k) calculating a reduced travel distance using the formula:

$D = [(X/2)(X/2) + (R*R)]^{1/2}$, wherein

D equals the reduced travel distance;

X equals the fixed stopping point differential distance; and

R equals the lateral offset distance; and

(l) attaching the first end of the clamping assembly to the pivot and attaching the second end of the clamping assembly to the flexible power transfer section so as to form a tethered flexible power conduit providing a reduced assembly tool travel envelope having a radius equal to the reduced travel distance.

28. (new) A method for performing assembly operations upon a plurality work-pieces moved by an automatic conveyance system, the method comprising the steps:

(a) providing an automatic conveyance system including a work-station defined along a conveyor footprint, the work-station comprising:

a work-station envelope;

a work station forward boundary; and

a work station rear boundary,

wherein the automatic conveyance system is adapted to move a plurality of work-pieces into the work-station from an upstream direction and out of the work-station along a downstream direction, each work-piece having at least one point-of-use, and

wherein the travel of such points-of-use along the conveyor footprint define a horizontal transport line,

wherein the work station is adapted to receive an in-station work-piece, the in-station work-piece having an in-station point-of-use for designated assembly operations within work station envelope, and

wherein the automatic conveyance system is adapted to que an out-of-station work-piece having an out-of-station points-of-use upstream and outside of work station envelope;

(b) providing a assembly tool comprising:

a base;

a pivot;

an end use device adapted to perform a designated assembly operation upon such points-of-use;

a flexible power transfer conduit having a first end connected to the base and a second end connected to the end use device, the flexible power transfer conduit extendable to a length that allows travel of the end use device within a assembly

tool travel envelope which overlaps the position of the in-station points-of-use on such in-station work-pieces and also overlaps at least one out-of-station points-of-use on such out-of-station work-piece;

(c) providing a clamping assembly having a first end adapted to attach to the pivot and a second end adapted to connected to the flexible power transfer conduit so as to restrict the travel of the travel of the end use device;

(d) measuring a work station differential distance, the work station differential distance being the scalar distance between the work station forward boundary and work station rear boundary;

(e) measuring an in-station point-of-use offset distance, the in-station point-of-use offset distance being the distance measured from the in-station point-of-use to the work station rear boundary, the in-station point-of-use offset distance being a positive value when measured along the downstream direction and negative when measured along the upstream direction;

(f) measuring an out-of-station point-of-use offset distance, the out-of-station point-of-use offset distance being the distance measured from the work station forward boundary to the out-of-station point-of-use, the out-of-station point-of-use offset distance being a positive value when measured along the downstream direction and negative when measured along the upstream direction;

(g) calculating a lateral offset distance, the lateral offset distance being the scalar distance measured between the pivot point and a horizontal transport line;

(h) calculating a pivot point positive horizontal offset using the formula: P = (X/2) + Y + Z, wherein:

P equals the pivot point horizontal offset distance;

X equals the work station differential distance;

Y equals the in-station point-of-use offset distance; and

Z equals the out-of-station point-of-use offset distance;

(i) calculating a pivot point negative horizontal offset using the formula: P = X - Y, wherein:

P equals the pivot point horizontal offset distance;

X equals the work station differential distance;

Y equals the in-station point-of-use offset distance; and

(j) positioning the pivot to a point being a pivot point horizontal offset distance from the second fixed stopping point and being the lateral offset distance from the horizontal transport line,

wherein, if the value of P is greater than the value of X, then the pivot point horizontal offset distance equals the pivot point negative horizontal offset distance, else the pivot point horizontal offset distance equals the pivot point positive horizontal offset distance

(k) calculating a reduced travel distance using the formula: $D = [(X/2)(X/2) + (R*R)]^{1/2}$, wherein

D equals the reduced travel distance;

X equals the fixed stopping point differential distance; and

R equals the lateral offset distance; and

(l) attaching the first end of the clamping assembly to the pivot and attaching the second end of the clamping assembly to the flexible power transfer section so as to form a tethered flexible power conduit providing a reduced assembly tool travel envelope having a radius equal to the reduced travel distance.